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THE SPATIAL STRUCTURE OF BALTIC SEA FERRY SERVICES

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Ferry service is a transport system of regular routes which links areas separated by water bodies. Sometimes ferries are the only connection of an island and the mainland which is not rare in the Baltic Sea. A typical example of this is the island of Saaremaa. Ferry service is the backbone of cargo and passenger traffic in the Baltic Sea region.
This article aims to describe the spatial structure of the ferry service in the Baltic Sea. To this end, a statistical database on 101 ferry routes has been built with passenger and car traffic on each being calculated with an original methodology, which in its turn can be applied in analysing the spatial structure and traffic of ferry services in other regions. Baltic ferries account for over half of all European ferry-borne car and passenger traffic. The Baltic stands out as a region with exceptionally long ferry routes which sustain timber exports. The main cargo shipping country in the region is Sweden.

Keywords:
ferries, ferry service, passenger traffic, car traffic, concentration areas, water area

Introduction

The physical geography of the Baltic Sea shores is propitious for the development of ferry service. Jutting out into the sea, many islands and peninsulas are formed by the water bassin, which create an irregular coastline. The construction of airports, bridges, and tunnels connecting all the islands and the shores of the gulfs and straits is expensive and not always feasible. That is why ferries provide principal transport links in such areas. A cheap and convenient means of transport, ferries can carry large cargoes and many passengers — up to 3,000 people and over 700 heavy vehicles.

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Ferry service is provided by vessels transporting cargoes, passengers, and motor vehicles — lorries, cars, trailers, buses, railway carriages, and locomotives. Train ferries carry railway carriages, cars, and passengers; car ferries — cars and passengers; passenger ferries — only passengers.

In case of busy tarffic lines are usually operated by up to 6—7 decked vessels with bow and stern ramps (double-ended ferries). Lower decks are for railway carriages and trailers, middle for cars and buses, upper for passengers.

This study aims to describe the spatial territorial structure of the ferry service system in the Baltic Sea.

The aim of this research sets the following **objectives**:

— to design a database on car-and-passenger ferry traffic in the Baltic Sea;

— to calculate car and passenger traffic for each ferry route by means of a authorial methodology;

— to map the busiest passenger and car traffic flows;

— to identify the busiest ferry routes in the Baltic Sea and in separate countries applying these maps;

— to identify the areas of ferry service concentration and areas with the largest passenger and car traffic flows;

— to describe the current spatial structure of ferry services in the Baltic Sea.

The necessity of this research is conditioned by the growing demand for maritime ferry services, particularly cargo operators on the one hand, and a very small number of researches on the functioning of the services and almost total lack of statistical data on the traffic on individual routes on the other.

The Baltic Sea is one of the busiest sea basins in the system of global maritime traffic, which is a key factor for the development of regional economies and trade. The high density of ferry routes in the Baltic Sea is a result of the economic strength of countries skirting the sea. In a compact region, ferries are a convenient and inexpensive way to carry passengers and cargoes. The Baltic region is an independent economic centre with a widely ramified transport network coalescing the economic potential, cultures, and human resources of several countries. Ferry services appeared in Baltic Sea states at different times to compensate for the lack of impossible land connections.

Most ferry routes connect two economic centres or production and distribution hubs specialising in a selected type of cargo, for example timber. A ferry network mostly develops in case the operating company considers such services cost-effective. Many ferry operators work on the same routes, thus straining the regional maritime transport system. The lack of research into the connection between traffic and its spatial distribution as well as into its dependence on the institutional factor precludes traffic optimisation despite the enormous potential of ferry services in the region. Our findings may facilitate the spatial planning of maritime ferry routes and support feasibility studies into ferry services in the Baltic Sea.

Below we will consider the ferry services of several Baltic countries to explore the role of ferry routes as modern maritime thoroughfares.

Literature review

The literature on the topic is scarce. That is why we analysed a wide range of sources on ferry transport, many of which are historical overviews of the emergence of ferry services in Europe [1; 2].

The collection of papers *Ferry Services in Europe* edited by Funda Yercan at Dokuz Eylul University in Izmir, Turkey, is the only work focusing entirely on maritime ferry services linking the European continent. The book comprises several articles on ferry services in different seas and analyses traffic between selected countries. Special attention is paid to the institutional framework for ferry services: competition from other operators, the transport infrastructure, and the technical configuration of the fleet. Yet, this publication does not contain passenger and car traffic data.

Researchers from different, not only European, countries have emphasised the significance of ferry service for the transport system of the Baltic region. The literature abounds with publications on the topic by specialists in economics, administration, marketing, and statistical modelling.

In their article, Odeck and Høyem [4] explore the impact of competitive tendering on the operational costs of ferry services. The authors conclude that competitive tendering might preclude free competition and produce monopolistic tendencies.

This approach can reduce demand since the main priority for the customer when choosing an operator is the fare. Passengers are growing concerned about the quality of services on board the ferry [5], wait time, and speed [6]. These new demands are a challenge for both operators and shipbuilders [7—10].

Seaport and ferry terminal operators have to modernise port complexes for serving modern ferries most effectively, particularly to unload ferries quickly and safely. Innovation is needed at the busiest ports and small distant harbours where the ferry is the only connection to the mainland.

The proper functioning of ferry services requires regular monitoring of the route network for unlocking new destinations and redistributing current traffic.

The spatial structure of ferry services has been analysed in a number of articles [18]. For example, Baird [11] compares the configuration of ferry networks in Japan and the UK, the makeup of ferry fleets, and the features of domestic and international traffic.

The spatial distribution of ferry services was carried out by Christopherson as early as 1973, along with an assessment of passenger and car traffic [12]. He links the concentration of ferry traffic in the south of the Baltic to a greater demand for recreation and a denser network of international roads.

A research group led by Škurić [13] has proposed methods to identify the optimal location of ferry terminals and the right fleet size [13]. Maiorov and Fetisov have devised formulas for forecasting traffic handled by ports to improve the quality of services provided by maritime passenger terminals [14].

The deficiencies of the current instrumental and methodological framework for maritime planning are investigated by Myakinenkov [15]. He believes that marine spatial planning is absent in Russia, whilst many European countries are active in this field. Effective usage of water areas for ferry services will require zoning by economic activities and thus localisation feasibility studies.

Implementing such plans demands knowledge from across different areas of the European marine economy. This approach will strengthen transboundary ties and contribute to a common transport system in Europe with roads and railways connected by ferry routes. Gumenyuk and Melnik emphasise that although road railway transport has a connecting function in the Baltic, maritime transport is essential for a regional transboundary transport system [16]. They also stress the need for an evidence-based transport system for all countries on the shores of the Baltic Sea.

The literature review shows that few publications analyse the spatial structure of ferry services or its role in the transport industry. Yet, researchers do not deny the cost-effectiveness of this means of transporting cargoes. Some of them consider ferries to be a propulsive development factor. Most publications, however, do not provide an exhaustive overview of ferry services. There is usually a lack of car and passenger traffic data or information on existing and prospective ferry routes. Research on ferry services does not explore their correlation with other means of transport or economic and geographical conditions necessary for a successful ferry terminal.

This article aims to fill this gap in research. Geographers have not analysed the spatial structure of Baltic ferry services for a long time. The findings of this study have practical implications since the proposed method for estimating ferry-borne passenger and car traffic facilitates planning shipping routes and zoning the Baltic Sea for ferry service improvement.

Methods

Statistics on selected ferry routes in Europe are almost absent. Most national statistical yearbooks contain general data on marine traffic and annual numbers for the whole country. Sometimes think tanks publish information on individual routes, but, in most cases, they merely report an increase or decrease in traffic compared to previous years. There are no statistics on the spatial distribution of traffic — data necessary for planning, control, and efficiency calculation. Another deficiency is the lack of open access to this information.

The absence of detailed geographical information on each ferry route has encouraged us to develop a methodology for calculating the indirect indicator of ferry traffic on individual routes. The indicator is computed based on the passenger and vehicle capacity of ferries, the number of vessels per route, and the number of crossings per vessel per week.

The capacity utilisation rate (0.7)[1] and the average number of weeks per year were also taken into account, along with capacity specifics. For instance, the lane meter measure, i.e. the total length of the space for heavy vehicles, was used for Ro-Ro cargoes. Sometimes this measure also included the length of the space for cars. In the latter case, the capacity was calculated at the rate of 6 m per car and 18 m per heavy vehicle, according to the regulation of the European Parliament Transport Department. It was assumed that a ferry carries 70 per cent of cars and 30 per cent of heavy vehicles. The three following formulas were worked out.

Passenger traffic

Passengers = $A \times B \times C_1 \times 0.7^* \times 52.1$;

Car traffic

Cars = $A \times B \times C_2 \times 0,7 \times 52,1 = A \times B \times (L/6) \times 0,7 \times 52,1$;

Heavy vehicles

HVs = $A \times B \times (L/18) \times 0.7 \times 52.1$;

where A is the number of crossings per week; B is the number of ferries on a route; C1 is the average passenger capacity; C2 is the average car capacity; L is the total length of the car space (lane meters); 0.7 is the capacity utilization rate; 52.1 is the average number of weeks per year.

Data necessary for the calculations were collated in two stages. Ferry booking websites and online newspapers were searched for information on regional ferry operators. Then ferry timetables for 2017, routes, and their descriptions were found on the official websites of the companies. The websites of ferry ports and terminals provided detailed information. This way, data on the destinations served by each company and weekly crossings were obtained. Then, the search focused on the number and models of vessels on each route. Identifying the type of vessel made it possible to determine the technical detail necessary for calculating passenger and vehicle capacity. The data were substituted into the formula.

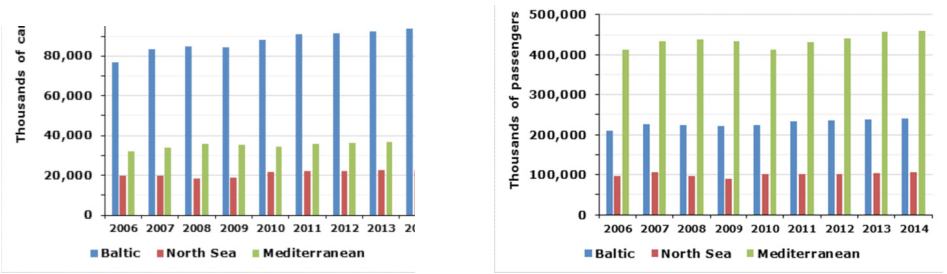
To illustrate, let us perform the calculation for the Oslo-Copenhagen ferry route, which is served by only one company — DFDS. Three vessel with a capacity of 378 passengers and 263 cars make a crossing once a day or seven times a week. By substituting these data into the formula we obtain the following: the passenger traffic on the route in 2017 was 578,998 people ≈ 579,000 people; the car traffic was 402,848 ≈ 403,000 cars. If several companies operated the route, the traffic handled by each would have been summed.

Results

Using the above methodology, we computed passenger and vehicle traffic for all 101 ferry routes.

[1] 0.7 is the standard capacity utilization rate for maritime transport. It is used when planning transport flows and designing vessels (to calculate optimum sizes) [17].

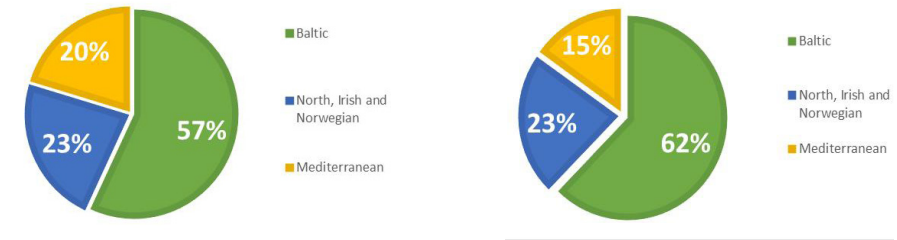
According to the European Parliament, the Baltic, North, and Mediterranean Seas accounted for most ferry operations in Europe (Fig. 1 a, b). About each second car was carried by ferry in the Baltic. In 2017, the proportion of the Baltic Sea in passenger traffic was 57 per cent; in car traffic, 62 per cent (Fig. 2 a, b).



a *b*

Fig. 1. Ferry-borne traffic: *a* — cars; *b* — passengers

Source: The Harbours Review, 2018, available at: http://harboursreview.com/ro-ro-i-ferry-atlas-europe-2016/17.pdf (accessed 23.11.2018).



a *b*

Fig. 2. The distribution of passenger (*a*) and car (*b*) traffic by European seas, 2017

Source: prepared by the authors based on the calculated data.

When collating information on maritime ferry operations and performing its primary analysis, we established that there is no regular service on many ferry routes, and some destinations are available only in selected seasons.

We focused on routes that have at least one regular crossing a week. Several seasonal routes, the total number of yearly crossings on which was 52 or higher, were also included in the sample to make it adequate and representative. Since ferries from Russian ports sail less often than once a week, none of such roots is analysed. Nor does the article consider ferry cruises.

After calculating the traffic flows meeting all the above conditions, we created a database on car and passenger ferry traffic by sea. All traffic flows were categorised into major, large, medium, and minor ones (according to their role in the European transport system). Table 1 demonstrates the characteristics of the four categories.

Table 1

Passenger and car ferry traffic in the Baltic Sea, 2017 (prepared by the authors based on the calculations)

Route category	Passenger traffic		Car traffic	
	from	to	From	to
Major	40,000,001	110,000,000	20,000,001	40,000,000
Large	20,000,001	40,000,000	5,000,001	20,000,000
Medium	1,500,001	20,000,000	500,001	5,000,000
Minor	1,000	1,500,000	100	500,000

Below we will look at the spatial structure of ferry services in the Baltic Sea at the level of countries accounting for most of the ferry traffic in the region — Denmark, Sweden, Germany, Poland, Estonia, and Finland.

Denmark

The physical geography of Denmark is conducive to the development of maritime transport, including ferry services. The country lies at the junction of the Baltic and North Seas, and its ferry operations have two distinct divisions — the Western European in the North Sea and the Eastern European in the Baltic Sea.

Two out of Europe's three busiest ferry routes run across the territorial sea of Denmark (the North Sea operations not considered). These are Puttgarden-Rødby and Helsingør-Helsingborg (fig. 3). Both routes are international: the former connects Denmark and Germany; the latter, Denmark and Sweden. Each carries more than 105 m people (2017) and 35 m cars a year. According to our calculations, the traffic is identical in both directions. Several factors explain this balance.

Firstly, the frequency of ferry services is the same in both directions (up to 10 crossings a day). Vessels on these routes have similar technical specifications and carry almost the same number of passengers and cars. The capacity of such ferries reaches 3,000 people and 800 vehicles.

Secondly, both routes link Copenhagen, situated on the island of Zealand, with the transport system of neighbouring countries and ensure the uninterrupted movement of people and goods to and from the city.

Thirdly, the fixed link between the islands of Lolland, Falster, and Zealand and the Øresund Bridge creates a high-performance intermodal transport corridor between the Nordic countries and continental Europe. Via Denmark, it connects the largest industrial clusters of Sweden (Helsingborg and Malmö in the south, Stockholm in the east, and the mining cluster in the north) with Hamburg — one of the busiest ports in Europe.

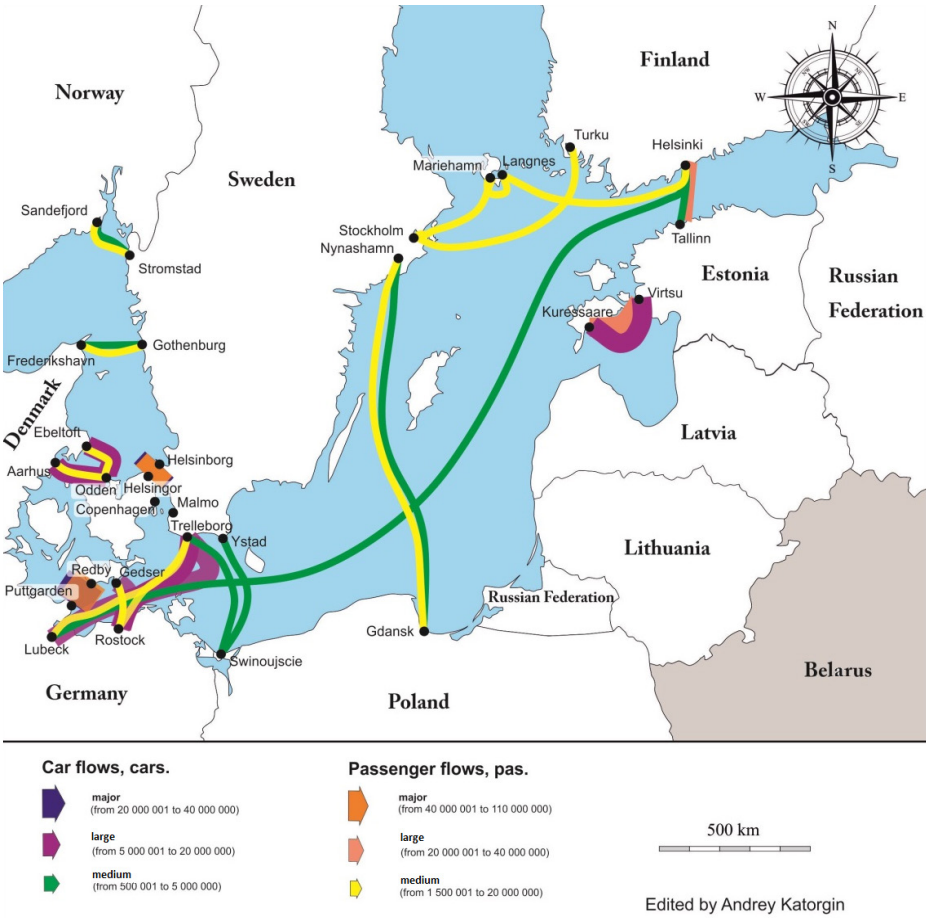


Fig. 3. The largest car and passenger flows in the Baltic Sea, 2017
(prepared by the authors)

Several medium traffic flows link Denmark to Germany (Rostok-Gedser) and Sweden (Frederikshavn-Gothenburg and Grenaa-Varberg). There are also important domestic ferry routes connecting the Jutland Peninsula and the island of Zealand. The car and passenger traffic between Odden (Zealand) to Aarhus and Ebeltoft (Jutland) is of medium intensity.

The location at the junction between the North and Baltic Sea and intermodal transport ferry services make Denmark a connecting country for multi-leg ferry routes in the Baltic Sea. Yet, only one of these routes, Fredericia-Klaipeda, is regular, i.e. there is more than one crossing a week. Ferries depart from Lithuania, stop at Copenhagen, and then reach Fredericia, from where the cargo (cars) moves to the North Sea port of Esbjerg. At Esbjerg, the cargo is forwarded to other ports, including British and Spanish maritime facilities.

This way, cargoes from Eastern Europe reach Western countries at a low cost and without much paperwork. Such multi-leg routes are not common in Denmark due to the inefficiency of interim uploadings for operators instead of a one-time loading or uploading at the destination port using sea ferries. The situation is similar in neighbouring Sweden.

Sweden

Sweden is the destination of many Baltic ferry services (fig. 4). Twenty-six passenger and 47 freight routes connect Sweden with other countries of the region. The link between Helsingør and Helsingborg accounts for the heaviest passenger and car traffic. The second and third busiest routes run from Trelleborg to Germany's Rostock and Lübeck. Ferries link the East of Germany to Nordic Europe, and since the port of Rostock gravitates to both Berlin and Hamburg, the whole northern part of Germany is covered by this transport connection.

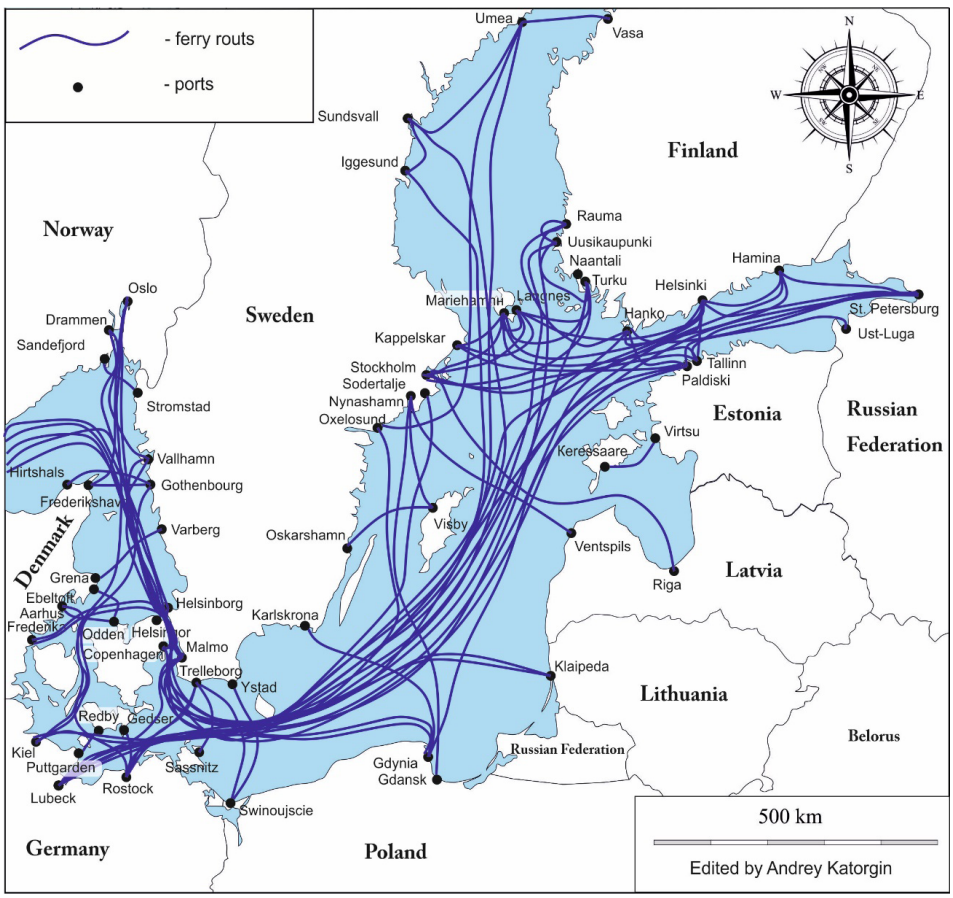


Fig. 4. Ferry routes in the Baltic Sea, 2017 (prepared by the authors)

Most passenger routes run to the Åland Islands — an archipelago in the north of the Baltic Sea. It is an autonomous region of Finland populated by Swedes and having a special multi-language status. Although the islands are part of Finland, they have more ferry links to Sweden than their metropole because of their primarily Swedish population. The passenger traffic between

Stockholm and Mariehamn, the autonomy's capital, is Sweden's second busiest passenger connection. Ferries run from Stockholm and its outport of Kapellskär to Mariehamn and Långnäs, a port on the eastern mainland of Åland. The large passenger flows are produced by both locals Finns and Swedes willing to economise. Since 1994, tax-free shopping is forbidden to EU residents on board vessels. However, the special status of the Åland islands allows operators to provide tax-free shopping services on the routes to Långnäs and Mariehamn.

Most freight ferries connecting Sweden and Finland carry Finnish timber and pulp.

The ferry services between Sweden and Poland have an important role for many Eastern European countries. Poland receives Swedish produce and forwards it to other states, including Russia. Goods are transported from the southern industrial cluster along the Trelleborg -Świnoujście and Ystad-Świnoujście routes; from the Stockholm cluster, along the Nynäshamn-Gdansk. These ferry lines are multi-leg routes, which are becoming commonplace in the Baltic. Cargos from the north-western part of the country reach the port of Malmö, where they are forwarded to both ports of neighbouring countries and the shores of the North Sea.

A specific feature of the Swedish transport system is coastwise traffic between the northern iron ore mines on the coast of the Bothnian Bay and the industrial clusters in the south and west of the country. There are also direct ferry routes to German ports and industrial centres.

Germany

German ferry services in the Baltic Sea are supported by large seaports attracting cargoes from around the world. When a container ship arrives, for example, at the port of Hamburg, it is unloaded, and containers are sorted to be transported by lorries, and vice versa, lorries carry containers that are loaded on container vessels bound to other countries. Germany has become the principal recipient of multi-leg ferry routes in the Baltic Sea. Rostock and Lubeck receive ferries from Sweden, Finland, Estonia, and Poland.

Conveniently situated between the large port of Hamburg and the country's capital, Berlin, these ports forward hi-tech equipment and chemicals for domestic needs, as well as iron ore from Sweden and timber from Finland, which are re-exported to the UK and Ireland. Other large traffic flows come to Lubeck from Trelleborg, Malmö, and Helsinki. The latter connection, classified as medium, is one of the 20 busiest in the Baltic.

Passenger traffic is less important for Germany as cargo transport. There are thrice less passenger routes as freight ones (nine against 30; fig. 5). All Germany's passenger routes connect it with Sweden, except for the Helsinki-Lubeck connection, most of whose passengers are crew members accompanying cargoes.

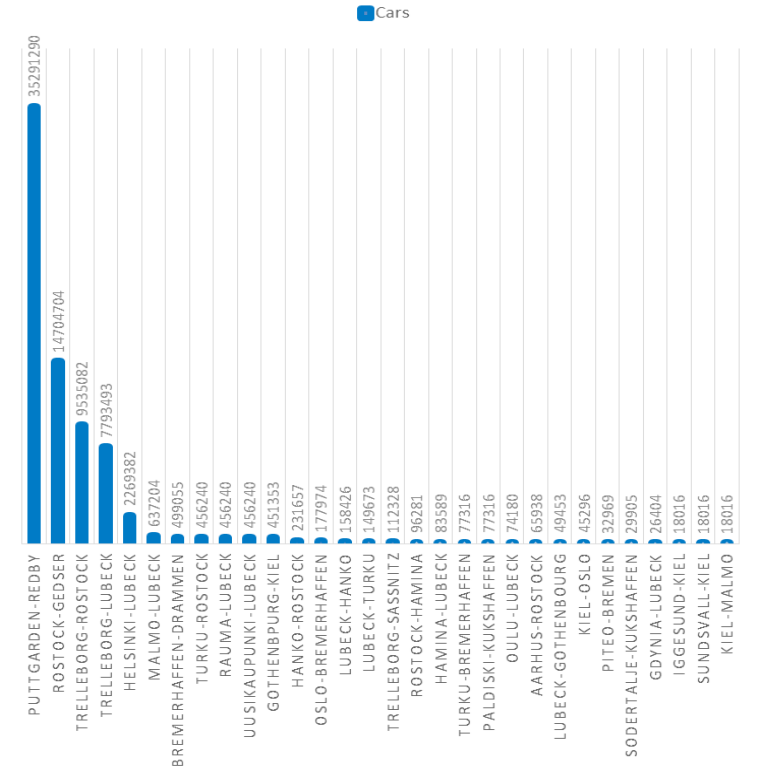


Fig. 5. Car traffic on German ferry routes (number of cars), 2017
(prepared by the authors based on the calculations)

Poland

Most of the country's ferry routes are multi-leg connections to Swedish industrial centres. Freight traffic is the largest between Poland's Świnoujście and Sweden's Trelleborg (about 4 m cars a year) and Ystad (1.5 m cars). The port of Gdynia has a ferry link to Wallhamn, which is connected in its turn to Norway's Drammen (the outport of Oslo) and Oslo proper. There is substantial car traffic between Estonia's Paldiski (a port near Tallinn) and Gdynia. The busiest ferry route is Gdansk- Nynäshamn.

These connections make Poland a transit country on the way of Nordic industrial goods to Eastern Europe. The country's developed road and railway network carries cargoes from its ports to Belarus and further to Russia. Poland also forwards cargoes to Slovakia, Ukraine, and the Czech Republic.

Passenger ferry services are not popular in Poland. Only three routes carry passengers: Trelleborg- Świnoujście, Karlskrona-Gdynia, and Ystad- Świnoujście. The total national passenger traffic is about 12 m people a year (2017).

Finland and Estonia

In 2017, Finland's ferry routes carried over 110 m passengers and 17 m cars. The busiest connection is between Helsinki and Tallinn. Classified as major by passenger traffic and medium by car traffic, it is one of the 20 busiest routes in the Baltic Sea and 50 in Europe (the fourth largest in Europe by passenger traffic and 12th by car traffic). There are several factors behind the popularity of this route. Firstly, it is sought after by tourists because of inexpensive fares and the short time of travel. Secondly, the Finns prefer doing shopping in Estonia, where taxes and thus retail prices are lower than in Finland.

A special tax regime explains the popularity of the Åland Islands as a destination. The substantial passenger traffic is also explained by the need for a connection to the mainland.

The irregular coastline necessitates coastwise traffic between the south-eastern and south-western coasts of the country (Rauma, Uusikaupunki, Naantali, Turku, Hanko, Helsinki, and Hamina). Some of these routes are part of connections between Finland and Russia (via St Petersburg), which account for substantial car (and much more modest passenger) traffic. St Petersburg receives vehicles from the ports of Hanko and Helsinki. Passengers come to the city only from Helsinki, and this traffic flow is classified as minor.

Multi-leg routes to Germany carry timber, pulp, and frozen food. The latest is transported from Finland to Estonia as well.

Tallinn has ferry connections to not only Helsinki but also the Åland Islands and Stockholm. These routes, however, carry less traffic than the domestic ferry service, which transported about 40 m people and 5 m cars in 2017 between the town of Virtsu in continental Estonia and Kuressaare, the administrative centre of Saare County in the West Estonian archipelago. Kuressaare lies on the island of Saaremaa, which could be reached until 2016 only by motorway 10. Still, the journey required taking a ferry between Virtsu and Kuivastu, where the distance to the island is the shortest. The route operator went bankrupt in 2016, and the service was discontinued to be replaced by the Virtsu-Kuressaare connection. This replacement proved effective. This new link reduced the time of travel to the administrative centre, which was the destination of most passengers, by several hours. The longer journey by sea was balanced out by travel by land made unnecessary. In 2017, this route became Estonia's second-busiest by passenger traffic and the largest by car traffic.

Conclusions

The ferry traffic in the Baltic Sea is among the busiest in the world. Two out of Europe's three principal ferry routes run across the region (Puttgarden-Rødby and Helsingør-Helsingborg). Many other routes are classified as large or medium by passenger and car traffic (fig. 6).

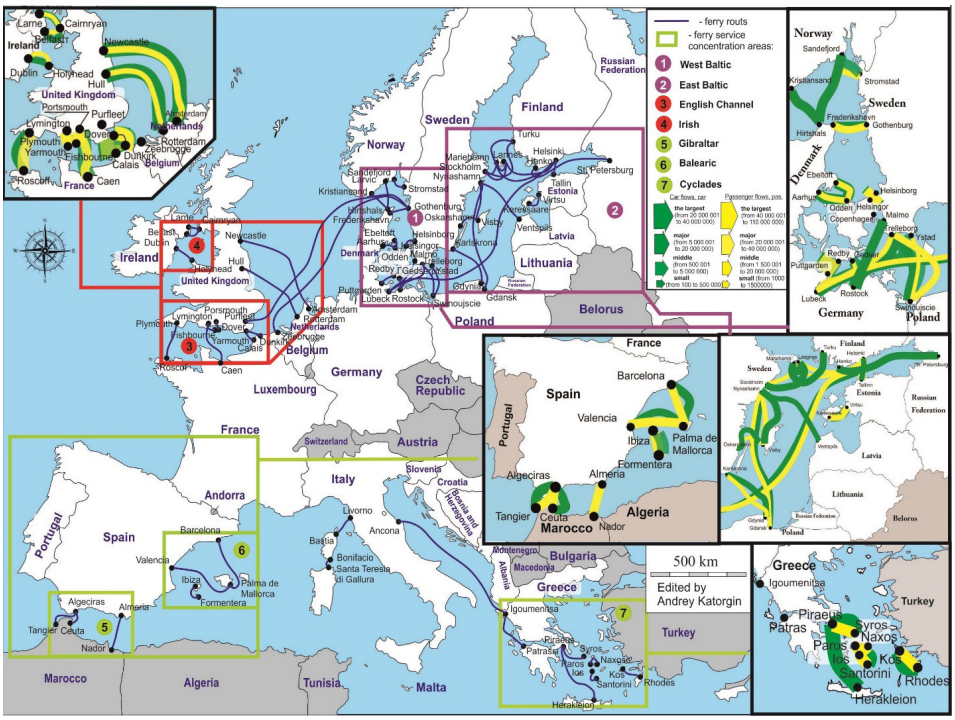
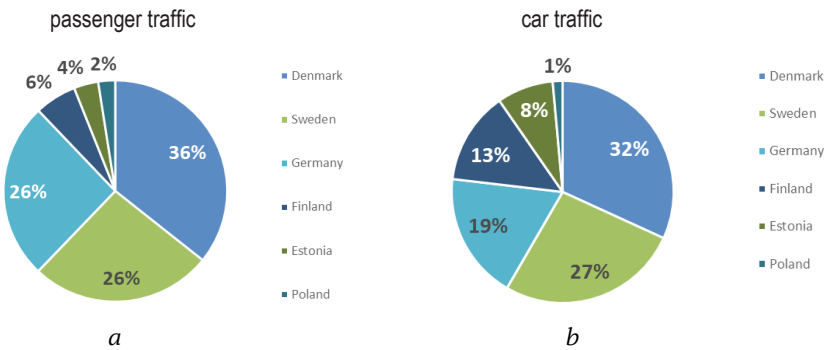


Fig. 6. Maritime ferry traffic in Europe, 2017
(prepared by the authors)

The ferry services between Germany, Denmark, and Sweden create a single transport corridor for delivering Nordic goods to other European countries. Moreover, these corridor makes possible the free movement of EU residents between neighbouring countries.

Denmark accounts for most of ferry-borne passenger and car traffic. The physical geography of the country, which makes it a likely transit hub, allows it to attract traffic flows from the North and Baltic Sea. Denmark is responsible for one-fourth of the passenger and car traffic carried by ferries (fig. 7, table 2).



a *b*

Fig. 7. The distribution of passenger (*a*) and car (*b*) traffic between Baltic ferry routes, 2017 (prepared by the authors based on the calculations)

Sweden is the principal source of cargo transported by ferries to the Baltic region states and Western European countries (the UK, Belgium, and Spain).

The total passenger (about 461 m people) and car (about 161 m units) traffic in the Baltic comprises 60 per cent of the total ferry traffic in Europe (fig. 2). Furthermore, regular ferry connections to Poland support the transit of Swedish and Norwegian goods to Eastern European countries, including Russia.

Table 2

A comparison of passenger and car traffic by country, 2017 (prepared by the authors based on the calculations)

Country	Passenger traffic		Vehicle traffic	
	1,000 people	% of the Baltic Sea total	Units	% of the Baltic Sea total
Denmark	260,000	32	103,000	36
Sweden	217,000	27	76,000	26
Germany	151,000	19	74,100	26
Finland	110,000	13	17,000	6
Estonia	67,100	8	10,130	4
Poland	11,804	1	7,056	2

Multi-leg routes are the hallmark of the Baltic. Most of them link German and Finnish ports and carry timber.

Another specific feature of Baltic ferry routes is casual travel to the Åland Islands for the sake of tax-free shopping. Lower prices are also the reason why Finns cross the Gulf of Finland to stock up in Estonia.

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References

1. Dunlop, G. 2002, The European ferry industry-challenges and changes, *International Journal of Transport Management*, vol. 10, no. 1, p. 115—116.

2. Uriasz, J. 2010, Baltic ferry transport, *Communications in Computer and Information Science*, no. 104, p. 160—167.

3. Yercan, F. 2018, *Ferry Services in Europe*, New York, Routledge.

4. Odeck, J., Høyem, H. 2020, The impact of competitive tendering on operational costs and market concentration in public transport: The Norwegian car ferry services, *Research in Transportation Economics*, no. 7, art. 100883. doi: https://doi.org/10.1016/j.retrec.2020.100883.

5. Laird, J. J. 2012, Valuing the quality of strategic ferry services to remote communities, *Research in Transportation Business and Management*, no. 10., p. 97—13.

6. Tørset, T. 2019, Waiting time for ferry services: Empirical evidence from Norway, *Case Studies on Transport Policy*, vol. 7, no. 3, p. 667—676.

7. Wang David, Z. W., Lo Hong, K. 2008, Multi-fleet ferry service network design with passenger preferences for differential services, *Transportation Research Part B: Methodological*, vol. 9, no. 42, p. 798—822.

8. Rehmatulla, N., Smitha, T., Tibbles, L. 2017, The relationship between EU's public procurement policies and energy efficiency of ferries in the EU, *Marine Policy*, vol. 75, no. 1, p. 278—289.

9. Gagatsia, E., Estrup, T., Halatsisa, A. 2016, Exploring the Potentials of Electrical Waterborne Transport in Europe: The E-ferry Concept, *Transportation Research Procedia*, no. 14, p. 1571—1580. doi: https://doi.org/10.1016/j.trpro.2016.05.122.

10. Lo, H. K., An, K. 2013, Ferry service network design under demand uncertainty, *Transportation Research. Part E: Logistics and Transportation Review*, no. 59, p. 48—70. doi: https://doi.org/10.1016/j.tre.2013.08.004.

11. Baird, A. J. 1999, A comparative study of the ferry industry in Japan and the UK, *Transport Reviews*, vol. 19, no. 1, p. 33—55.

12. Christophervon, S-S. 1973, Internationell färjetrafic på Östersjön, *Sven. geogr. årsb. Årg. Lund.*, no. 49, p. 78—94.

13. Škurića, M., Maraš, V., Davidović, T., Radonjić, A. 2020, Optimal allocating and sizing of passenger ferry fleet in maritime transport, *Research in Transportation Economics*, no. 8, art. 100868. doi: https://doi.org/10.1016/j.retrec.2020.100868.

14. Maiorov, N., Fetisov, V., Krile, S., Miskovic, D. 2019, Forecasting of the route network of ferry and cruise lines based on simulation and intelligent transport systems, *Transport Problems*, vol. 14, no. 2, p. 111—121. doi: https://doi.org/10.20858/tp.2019.14.2.10

15. Myakinenkov, V. M. 2013, Key Strategies of Development of Research Tools and Methods for Marine Spatial Planning, *Balt. Reg.,* no. 1, p. 71—81. doi: https://doi.org/10.5922/2079-8555-2013-1-7.

16. Gumenyuk, I. S., Melnik, D. A. 2012, The transnational territorial transport system of the Baltic Region, *Balt. Reg.,* no. 1, p. 66—71. doi: https://doi.org/10.5922/2079-8555-2012-1-8.

17. Pustoshny, A. V., Moe, V. 2016, Prospects for the development of high-speed water transport in Myanmar, Morskoi vestnik [Marine Bulletin], vol. 9, no. 3, p. 92—94 (in Russ.).

18. Baird, A. J. 1997, A Scottish east coast European ferry service: review of the issues, *Journal of Transport Geography*, vol. 41, no. 5, p. 291—302.

19. Backer, H., Frias, M. 2012, Planning the Bothnian sea. In: *Plan Bothnia*, Helsinki.

20. Corlay, G-P. 1982, Les ports de pêche danois, *Pêche mar*, vol. 61, no. 1253, p. 433—442.

21. Flieger, W. 1990, Mit dem Auto über die Ostsee, *George, heute*, vol. 11, no. 80, p. 23—24, p. 29—31.

22. Baturova, G. V. 2011, Regional maritime clusters as the basis for the socio-economic development of coastal territories, Strategicheskoe planirovanie v regionakh i gorodakh Rossii [Strategic planning in regions and cities of Russiareports of the participants of the IX All-Russian Forum Strategic planning in regions and cities of Russia, St. Petersburg, p. 115—119 (in Russ.).

23. Gorkin, A. P. 2013, *Sotsial'no-ekonomicheskaya geografiya: ponyatiya i terminy* [Socio-economic geography: concepts and terms], Smolensk, Oikumena (in Russ.).

24. Gumenyuk, I. S., Orlov, S.V. 2014, The Kaliningrad Region as a Potential Coastal Transport Cluster, Balt. Reg., no. 3, p.121—131. doi: https://doi.org/10.5922/2079-8555-2014-3-9.

25. Pustoshny, A. V. 2013, Prospects for High-Speed Water Transport in Russia, *Herald of the Russian Academy of Sciences*, vol. 83, no. 6, p. 506—512. doi: 10.1134/s10193316/4010043 (in Russ.).

26. Gee, K., Kannen, A., Heinrichs, B. 2011, Towards a common spatial vision: Implications of the international and national policy context for Baltic Sea space and MSP, *BaltSeaPlan*, Report 8. Geesthacht.

27. Geuckler, M. 1991, Die Verkehrsinfrastruktur in der Region Südliche Ostsee, *Bundesbahn*, vol. 67, no. 3, p. 302.

28. Jahrb, A. 1968, Die feste Verbindung über den Øresund, *Wirtsch. Ostseeraum*, p. 72—76.

29. Knudsen, A. 1961, Hirtshals havn — nyt vestbassin, *Beton-teknik*, vol. 27, no. 4, p. 139—148.

30. Koch, M. 1980, Der Fährverkehr Skandinavien-BDR, DDR und Polen, *HANSA*, vol. 117, no. 10, p. 705—708.

31. Rasmussen, H. 1979, Prospects for 1979 by the Mayor of Esbjerg, *Ports and Harbors*, vol. 24, no. 3, p. 36.

32. Syafruddin, C. 2016, Assessing Service Quality of Passenger Ferry Services in Sabang Zone, *European Journal of Business and Management*, vol. 9, no. 5, p. 22—34.

33. Westerholm, J. 1986, The development of a national port system — Denmark, *Fennia*, vol. 164, no. 2, p. 211—290.

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